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9 October 1963

Copy 3**MEMORANDUM FOR:**

Air Force Special Projects-10
Office of the Secretary of the Air Force

SUBJECT: Substantive Evaluation of Mission 4002

1. As a supplement to the PET evaluation, NPIC has compiled a substantive evaluation of Mission 4002. This is the second payload received from the KH-7 camera system. Consequently, evaluations must be based on correlations between the two products, and the design specifications of the manufacturer. The degree of success achieved by this camera system in reliably gathering intelligence data was determined through two methods of evaluations: a subjective analysis of Photo Interpretation (PI) suitability, and objective mensural studies.

2. Photo Interpretation suitability was determined through a detailed analysis of target areas by Technical Intelligence Division personnel, supplemented by close liaison with the NPIC exploitation Photo Interpreters (PIs) and a comprehensive study of their published reports. Objective mensural data was obtained through definitive studies of film speed, yaw slit analysis and mensural error computations.

3. An apparent discrepancy exists between the size of the smallest objects measured by the technical analysis group and the size of the smallest objects identified by the PIs. There are two reasons for this difference. First, the PI identifies an object by analyzing its components and then verifies his observations through association and when possible with collateral information. Using as an example the engine nacelles of an aircraft, the PI would identify the aircraft and by analyzing its components, identify the nacelles. However, if these nacelles were not attached to an aircraft but rather stored on the ground, the PI would very probably report them as unidentified storage. They may still be measured by instruments but as measurements are only one of the many clues needed for positive identification, the nacelles would remain on the report as unidentified storage. Secondly, in this type of evaluation, the dimensions of objects reported by the technical analyst are generally from measurements made of maximum contrast images that may

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or may not have intelligence value. Though these dimensions are important they should not be construed as minimum ground resolution figures in terms of PI recognition. It is well to remember that as contrast diminishes image edges become less distinct and that this will directly influence reported PI detail and mensural accuracy. Contrast may well be the major influencing factor in PI reliability.

4. Subjectively, reports published by the intelligence community on targets covered by Mission 4002 display a marked improvement in the confidence level of the PI and technical analyst. The percent of error in measurements, (the + or - remarks), and the number of possibles or probables, have diminished with a resultant increase in report reliability. It appears pertinent to mention that no PI comments on targets covered previously in KH-4 photography had to be retracted, but Mission 4002 coverage of these targets verified the existence of several objects previously reported as suspected or probable.

5. For your information, the name NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER is classified **CONFIDENTIAL**; therefore, it may not be used as a mailing address going through unclassified channels. Correspondence intended for this Center should be addressed to the individual concerned, c/o Central Intelligence Agency, Washington, D. C. (20505).

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ARTHUR C. LUNDHALM
Director

Enclosures:

- 1 - Evaluation of PI Suitability
- 2 - Film Speed Analysis
- 3 - Mensural Error Study
- 4 - Illustration of Apparent Mode Combinations Pass D31E
- 5 - Graph of Film Speed Pass D15E Frame 004
- 6 - Graph of Film Speed Pass D15E Frame 015
- 7 - Graph of Film Speed Pass D15E Frame 016
- 8 - Graph of Film Speed Pass D24 Frame 004
- 9 - Drawing of DC 3 Aircraft

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EVALUATION OF PI SUITABILITY, MISSION 4002

1. It is the general opinion of the Center that Mission 4002 is superior to Mission 4001 in all respects and did, in fact, within the experience of NPIC, produce the best satellite photography to date. Target coverage was accomplished as programmed, without vehicle or camera malfunction. However, the modes of operation were confined to strip photography and stereo pairs in the vertical position only. The roll-pointer reliability of the KH-7 system has not yet been demonstrated.

2. A notable contribution to the success of Mission 4002 is the verification and positive identification of targets previously classified as "suspect". In addition, a number of completely new identifications (targets not previously identified, either in Mission 4001 or in other KH photography) were made. Examples follow:

a. Three objects in a target area of prime interest previously described as possible radomes, and now positively distinguished as 2 radomes with a small building between them.

b. The leg dimensions of an interferometer were found to be exaggerated and dimensions to closer limits were established.

c. Additional details of target areas previously not detected are now observed, such as the scope of vehicular and rail activities and identification, as such, of towers, fences etc.

d. Verification and type-identification of previous "possible radar" installations and similar objects.

e. New identification of missile launch areas and individual sites either not previously detected or unidentifiable to date.

3. A variety of small, non-linear targets are readily identified within acceptable limits of accuracy down to the order of 8-10 feet.
Examples:

a. Cabs of tractor-trailer vehicles.

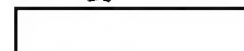
b. Anti-submarine net buoys.

c. Helicopter landing circles aboard ships.

d. Individual crates, drums, and timbers in storage areas.

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4. In addition, motor vehicle and rail car types are distinguishable and can be classified as automobiles, trucks, buses, box cars, hoppers, tank cars, etc. Guide lines and stalls in motor vehicle parking lots are easily detected, although the guide lines are bloomed out of true scale.

5. In the linear target class, the individual rails in RR trackage are distinguishable, as are the center divider lines painted on main highways, however such targets are observed to be bloomed.

6. While Mission 4002 was definitely successful in achieving some of the best image quality to date from satellite photography, some degradations do exist. Below are short descriptions of the most obvious problem areas:

a. Image Motion. Definite image degradation may be observed in areas of banding at the beginning of all frames, as well as in the area of looper action on the longer frames.

b. Focus. "Softness" of imagery has been noticed in isolated instances throughout this mission. Of special note are pass D08 frames 12, 13; pass D14 frames 2, 3; pass D24 frames 10, 11. There may be a correlation between this apparent focus problem and the longer film strips exposed prior to these frames. Further study must be conducted along these lines before definite conclusions can be reached. The frames in Pass D31 present a different problem in that all frames appear out of focus. Indications are that this may have been accomplished intentionally as a part of an experiment, but since the Center has no definite knowledge of this fact, the problem is mentioned for the record.

c. Exposure. A definite correlation may be observed between sun angle (consequently exposure) and image quality. Low contrast images, especially those under cloud shadows, are definitely degraded and some imagery is lost when sun angles fall below 20°. Exposure appears optimum in areas where the sun angles fall between 30° and 50°. Overexposure may be associated with sun angles in excess of 70°.

d. Scratches. Several camera induced scratches appear continuously throughout the film. Though image loss per frame is very minor percentagewise, total loss for the entire mission becomes significant.

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Scratches occasionally distort images immediately adjacent to them, causing difficulties in mensuration.

e. Streaks. Minus-density streaks appear throughout the original negative, parallel to film direction. As many as two hundred individual streaks have been counted on a frame. The majority of these appear to be caused by obstructions in the slit, however the possibility of camera roller problems must also be considered. Again image loss within a frame is minor but significant. The presence of seven of the streaks in the yaw slit area caused some difficulty in making measurements.

f. Coverage. Some apprehensiveness was caused by the lack of complete coverage over important target areas. The question was raised as to whether the PI would ever be able to get complete stereo coverage from one mission over targets covering a considerable number of square miles. Since large area coverage appears irreconcilable with a pointer type system, solution to this problem must be regarded as paramount if PI requirements are to be satisfied.

g. Weather. The problem of limited coverage is again apparent when adverse atmospheric conditions are encountered. Should 65 percent of a KH-4 mission be cloud covered, thousands of square miles of target area are still observable. However, if 65 percent of a KH-7 mission is cloud covered, very few square miles of selected target areas will be available for study. Obviously meteorology does assist the program planners in selecting target coverage on KH-4 missions, but it is beyond their realm to attempt positioning every cumulus cloud over the target area. It is equally obvious that one small cloud will totally obliterate an important target and consequently obviate a whole frame of KH-7 photography.

h. An unusual apparent combination of modes were encountered at the end of pass D3LE where partial overlapping occurred between two strip frames, followed by a laterally-offset frame at the termination of the pass. NPIC is not aware at present of any programming that may have induced this deviation from the normal mode of operation, but the possibility exists that these frames were experimental. Refer to Enclosure 3 for an illustration of the apparent mode combinations.

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FILM SPEED ANALYSIS OF MISSION 4002

1. The film speed was determined from measurements made with [] comparators; these instruments have a least reading of one micron. The 1/20th second time marks on the film were measured and converted to inches per second. The computed film speed was compared with both the programmed speed, and with what it should have been i.e., film speed derived from actual velocity and attitude data.

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2. There was considerable banding due to film speed error at the start of each frame and continuing for the first 1.5 seconds of operation. The graphs for sample frames reproduced at the end of this report show this film speed variation. The variations in speed coincide with the bands. The variation on Mission 4002 was more pronounced and constant than on Mission 4001.

3. During the film speed test on pass D15 the pattern changed slightly as can be seen on the graph for frame 4. The film speed as represented by enclosures 5 to 8 shows a definite pattern in a plus and minus direction. When the film speed is within $\frac{1}{2}$ of 1 percent of the correct speed, the imagery is considered better and more consistent than when the film speed is in error by more than $\frac{1}{2}$ of 1 percent.

4. The binary readout of the time track on Mission 4002 showed no evidence of malfunction and the time words were all compatible with the command list times. The time track operated perfectly throughout the mission and again proved its worth in computing film speed, mensuration, and correlation of data.

5. The definition of the yaw slit imagery on Mission 4002 was better than that of Mission 4001. The yaw slit measurements were easier to make on Mission 4002 and as many as 46 measurements were made on individual frames.

6. The computations for roll from the yaw slit measurements do not produce a roll attitude value that appears correct. The looper areas were not studied to any great extent on this mission.

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MENSURAL ERROR STUDY MISSION 4002

1. An error study was made on frame 4 pass D15E (monoscopic),

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twelve types of aircraft were easily identified. These twelve aircraft, for which accurate dimensions were available, were selected to make the error study. The aircraft vary in size from 35 to 101 feet.

Aircraft	Actual Values		Measured Values	
	Span Ft. In.	Length Ft. In.	Span Ft.	Length Ft.
KC-97	141 3	110 4	148	106
707	130 10	134 6	131	131
Constellation				
1049	123 0	113 7	117	84
DC-4	117 6	93 11	124	88
C-119	109 3	86 6	106	86
P-47	103 10	91 8	115	92
Electra	99 0	104 0	102	100
Convair 440	105 4	79 2	107	82
F-27	95 2	77 2	102	79
DC-3	95 0	64 2	91	63
T-39	44 5	43 9	48	41
Aero Commander	44 0	35 5	51	32

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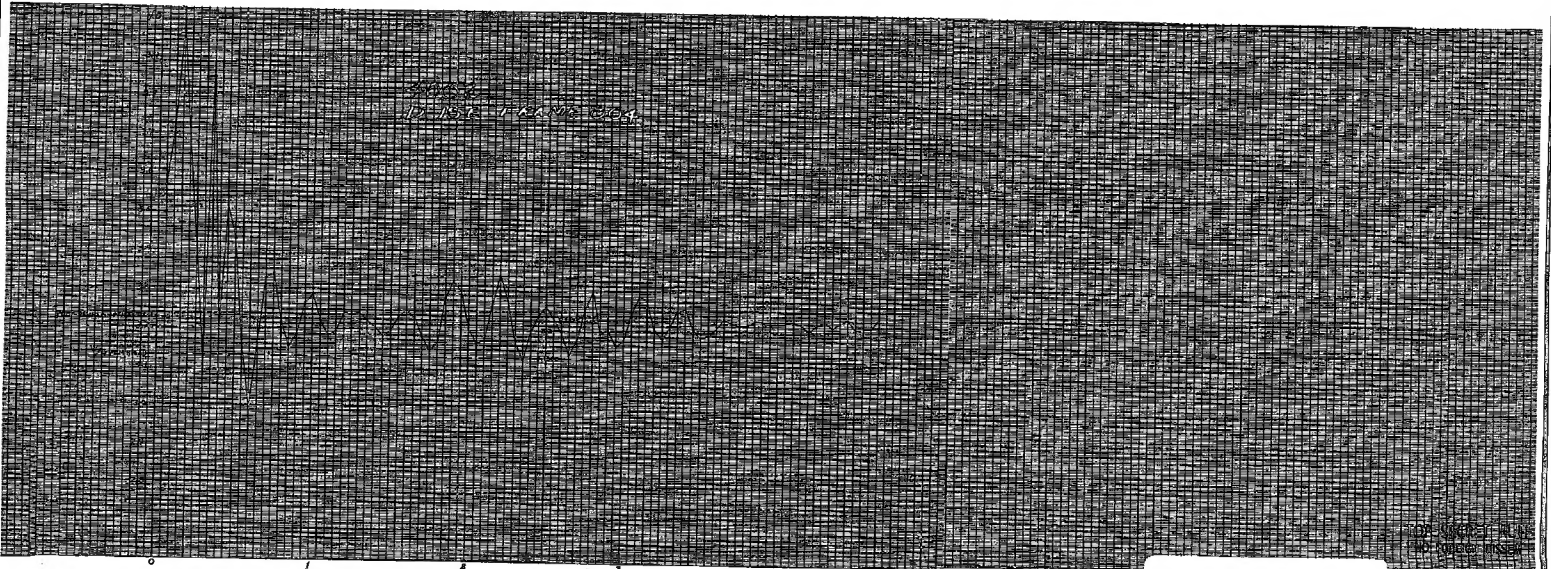
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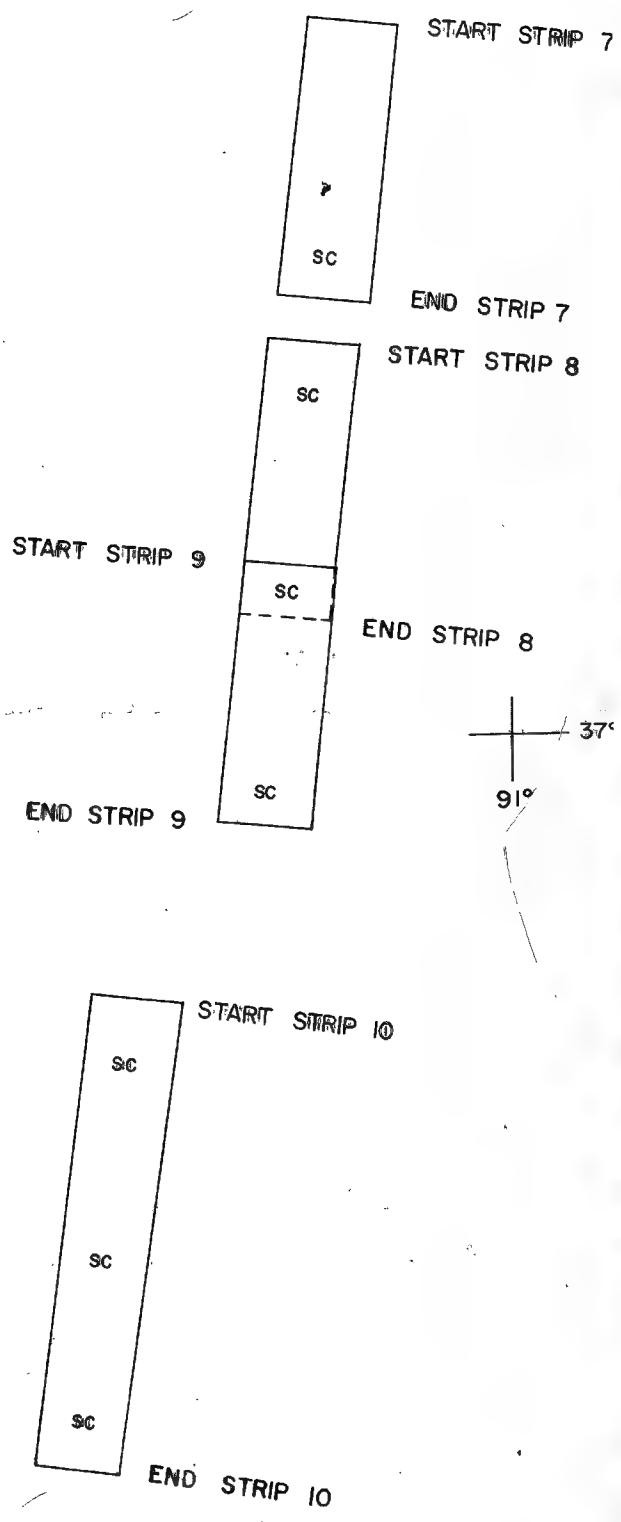
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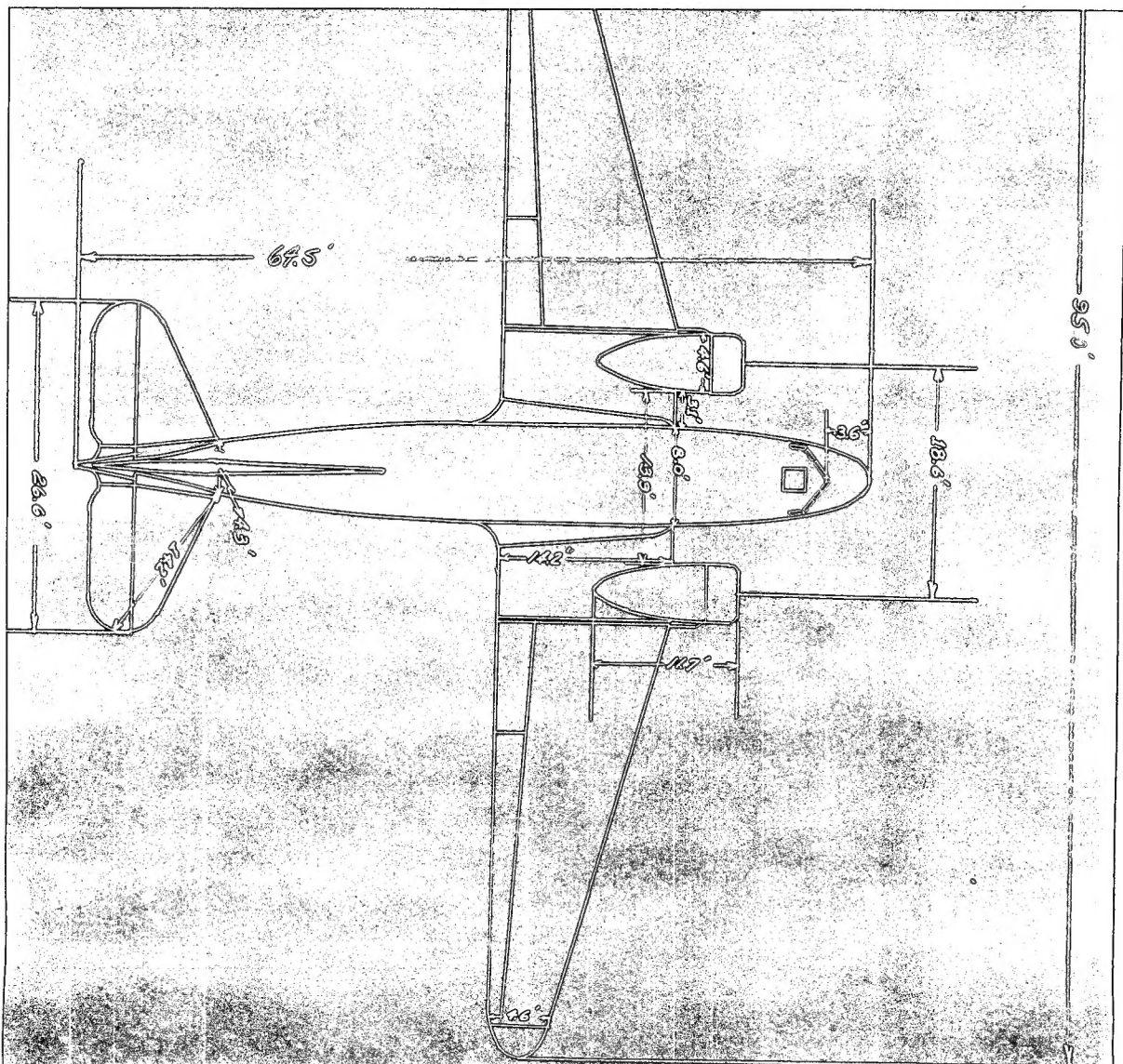
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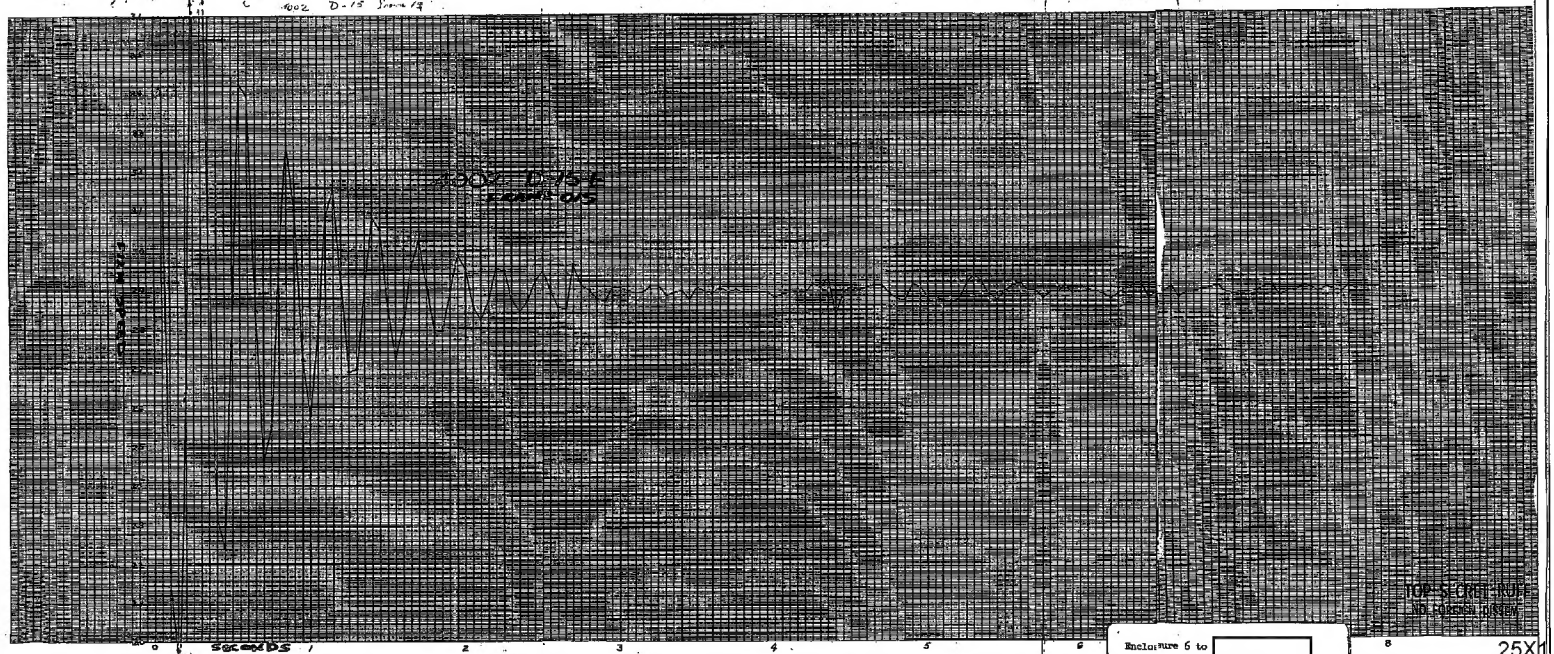
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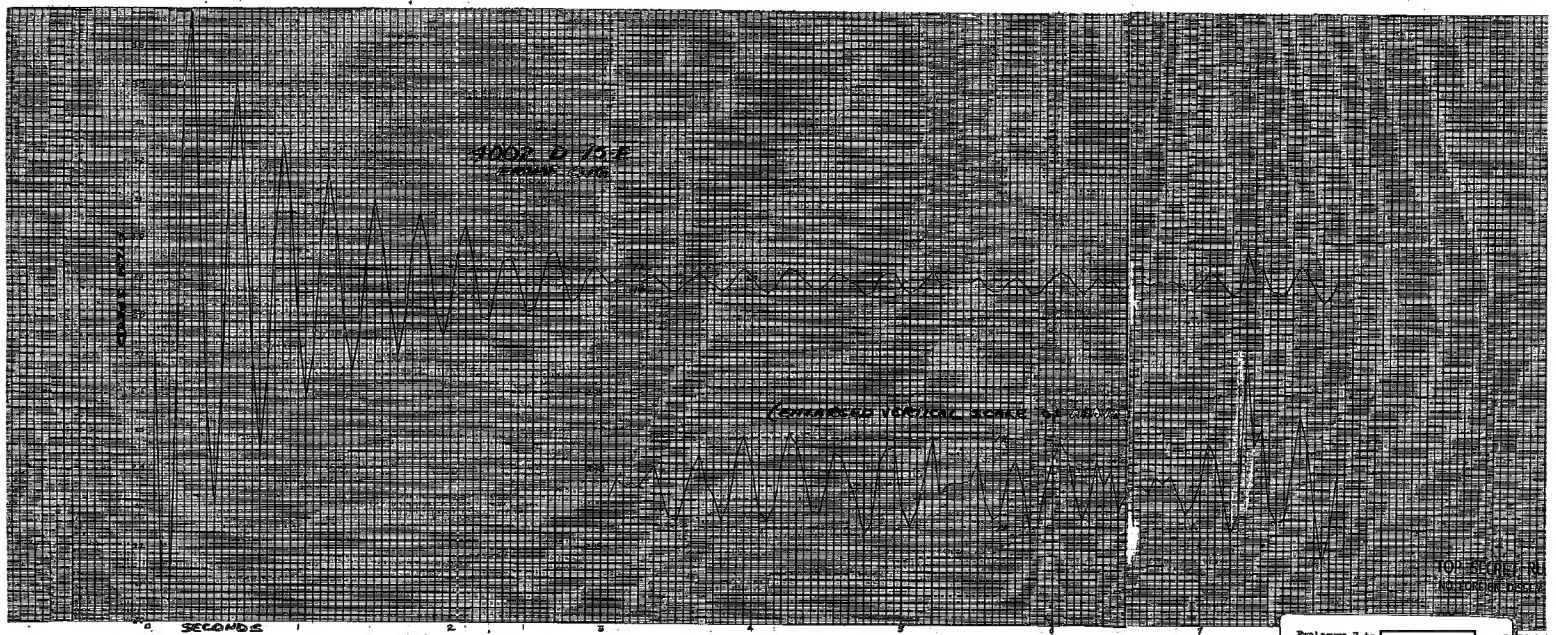
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